AUSTRALASIAN JOURNAL OF **PARAMEDICINE**

Does wound irrigation in the pre-hospital environment affect infection rates? – A review of the literature

Lynsey Smit
Monash University, Victoria

Malcolm Boyle
Monash University, Victoria

Literature review

Does wound irrigation in the pre-hospital environment affect infection rates? – A review of the literature

Lynsey Smit,¹ Malcolm Boyle PhD¹

Affiliation:

¹Department of Community Emergency Health and Paramedic Practice, Monash University, Victoria

Abstract

Introduction

Historically it has been shown in the military combat setting that early irrigation of open wounds and fractures effectively assists in the prevention of infection. The objective of this study was to determine whether wound irrigation alone in the civilian pre-hospital environment affects wound infection rates.

Methods

A literature search of the CINAHL, Cochrane Collaboration, EMBASE and MEDLINE electronic medical databases was conducted for articles published between January 1950 and March 2015. An existing pre-hospital search filter was applied to each database with additional search terms 'wound', 'traumatic wound', 'simple wound', 'irrigation', 'fluid irrigation', and 'infection rate'. Articles of any study design were included if they reported on the effect of wound irrigation and wound infection rates. Reference lists of included articles were also reviewed. Articles were excluded if they were not written in English, involving animals, or were from the military setting.

Results

A total of 1,648 articles were identified with eight meeting the inclusion criteria. These eight articles were from the military combat setting, which were excluded. However, as there were no specific civilian pre-hospital articles identified in the search a decision was made to include hospital emergency department (ED) and military data as a substitute to investigate the effectiveness of wound irrigation in decreasing wound infection rates.

Conclusion

The available evidence does not clearly prove that irrigation alone prevents infection, nor does it prove that removing irrigation from wound care would increase wound infection rates. Therefore wound irrigation should remain part of civilian pre-hospital wound care until further high-level studies can be undertaken.

Keywords

traumatic wound; simple wound; irrigation; infection rate; emergency medical technicians; pre-hospital, paramedic

Corresponding Author: Lynsey Smit, lynseysmit@hotmail.com

Introduction

Historically it has been shown in the military combat setting that early irrigation of open wounds and fractures effectively assists in the prevention of infection (1-5). Irrigation is therefore still seen as one of the main components in adequate wound care in the military combat setting (4,6). Civilian pre-hospital care usually has strong similarities to pre-hospital care in a combat setting. Irrigation of open wounds in the civilian pre-hospital setting can be considered standard (7). In Australia during 2004-2005 it was found that 49% all persons with recent injuries sustained open wounds (1).

Studies investigating the use of various fluid types have not come to consensus about which is the best fluid to use in the irrigation process. The studies have compared normal saline with tap water, Castile soap and normal saline, and normal saline alone (3,7-11). The results of these studies show little difference between intervention and control, except for the study by Hollander et al which showed a statistically significant lower infection rate in children compared to adults, even though many of the children's wounds were not irrigated (3).

There is a lack of solid evidence supporting the volume of fluid when irrigating a wound. In the military setting, Murray et al used volumes between 3 and 9 litres, with the volume dependent on the type and severity of the wound (12).

The use of low-pressure and high-pressure irrigation has likewise not realised statistically significant findings. It appears that low-pressure irrigation is as effective as high-pressure irrigation but is much easier to perform (9,11,12).

Civilian pre-hospital wound care is limited in comparison to hospital management due to the training and equipment of pre-hospital care providers. The commonly, but not exclusively, accepted management of wound care in the civilian pre-hospital setting consists of irrigation where necessary, bandaging or covering of the wound where necessary, pain relief as required, and transportation to hospital if required (13-15). The objective of this study was to determine whether wound irrigation in the civilian pre-hospital environment affects wound infection rates.

Methodology

Study design

A literature review of medical related electronic databases was conducted to identify if wound irrigation has an effect on infection rates in the civilian pre-hospital setting.

Definitions

Definitions of terminology used throughout this paper:

Civilian pre-hospital environment: Any out-of-hospital treatment environment that is not part of the military. Treatment providers include, and are not limited to, ambulance personnel, first-

aid providers, emergency medical technicians (EMTs), and paramedics.

Military setting: Pre-hospital treatment provided in a combat zone, or military controlled area.

Procedures

A literature search of the electronic medical databases CINAHL, Cochrane Central, EMBASE and MEDLINE was conducted. The databases were reviewed from their beginning until the end of March 2015. A pre-hospital search filter (16) was applied to each database with additional the search terms of 'wound', 'traumatic wound', 'simple wound', 'irrigation', 'fluid irrigation', and 'infection rate'. The keywords were used individually and in combination.

Articles of any study design were included if they reported on wound irrigation and the effect on wound infection rates. The reference lists of included articles were also reviewed. Articles were excluded if they were not written in English, or involved animals.

Results

A total of 1,648 articles were identified in the search with eight meeting the inclusion criteria. There were no additional articles identified in the reference list of retrieved articles.

There were no civilian pre-hospital-specific articles identified in the search, however there were eight articles from the military combat setting which were excluded. Seven of the military articles were consensus statements or reviews about specific combat related injuries and the current evidence supporting their management. Other articles identified in the search were hospital emergency department (ED) related.

As there was no specific literature for the pre-hospital setting, hospital ED and military data was used as a substitute to investigate the effectiveness of wound irrigation in decreasing infection rates.

Discussion

The search failed to locate any civilian pre-hospital wound irrigation articles, however, it is an important issue with unresolved questions and further research required. Irrigation has become a fundamental standard component of wound care over the years (2).

Whether irrigation alone critically influences infections rates is unclear. Wound infection is multifactorial, making analyses of individual wound care components, such as irrigation, challenging (2). The civilian and military data contrast each other at times.

This discussion will look at five specific areas: types of data present, characteristics of patients examined, types of wounds examined, types of irrigation fluid, and irrigation pressure. This discussion will aim to examine, as best possible, the effect of irrigation alone on infection rates.

Data types

There were two types of data identified: pre-hospital military data and civilian hospital ED data. The civilian data was from only the hospital ED setting. Combat data predominantly provided treatment guidelines based on the scientific literature. One combat study, retrospectively reviewed data from a single battalion aid station (2). Although none of the papers identified specifically analysed paramedic/medic irrigation practices and its effect on wound infection rates, is it reasonable to assume that the military and hospital ED data can be applied to paramedic practice where the situations are similar. A point of difference emphasised in all combat papers was the difference in wound patterns between the civilian and military setting. These differences will be discussed under wound characteristics.

Patient characteristics

Patients varied in age groups for the identified articles. The youngest included was a patient aged one year (8). There was no set maximum age for exclusion in any of the studies. The exclusion criteria varied between studies with common criteria for exclusion being: patients with any immunocompromise present, diabetics, patients on antibiotics, patients with infections present, injuries sustained >6-8 hours prior to ED presentation, grossly contaminated wounds, wounds involving muscle/bone/tendon/joint, bite wounds, and prisoners. With such specific exclusion criteria there may have been numerous patients that were excluded which may have caused the results to be skewed as only fit and healthy individuals with no grossly contaminated wounds were included.

Wound characteristics

As with patient characteristics, the types of wounds analysed varied across the studies. Civilian data included simple lacerations, open fractures, and chemical burns (3,7,8,10,11,17,18). The combat data reviewed covered battle casualties with a variety of wounds, predominately penetrating combat wounds (2).

In the military setting it is current practice to irrigate combat-related extremity injuries and central nervous system (CNS) injuries. There have been no studies investigating the effect of irrigation on infection rates in the combat setting. Combat-related wounds are generally as a result of high velocity projectiles and tend to be prone to contamination as a result of environmental factors (2). Thus, recommendations were made

to continue irrigation as per current practise for combat-related extremity injuries and CNS injuries (9,12,19).

Logistical constraints, such as delayed evacuation and treatment, differ in the combat and civilian settings. The spectrum of wounds covered in the identified studies was very broad and, as a result, generalisation of results are challenging. For example, there are many types of open fractures that may require different irrigation and treatment approaches. Therefore the irrigation treatment given for one type of fracture may not be generalised to other types of fractures.

More specific and detailed research is required to establish which type of wound may or may not benefit from which type of irrigation and treatment approach.

Types of irrigation fluid

As with patient and wound characteristics there were varying types of fluid used for irrigation. Hollander et al found that most paediatric patients included in their study received gentle scrubbing rather than irrigation (3). These paediatric patients were found to have lower infection rates than the adult patients who received mostly irrigation. Hollander et al argued that 'non-contaminated' wounds, such as the wounds mostly sustained by the paediatric patients, often had low bacterial colonies and therefore the need for irrigation may be unclear (3). They also argued that there were no clinical studies that clearly demonstrate the effectiveness of irrigation in reducing infection rates.

Two studies have compared tap water to normal saline for irrigation (7,8). Both studies found similar infection rates among control groups and suggested that pending further research, tap water may be safe and effective for wound irrigation. The aforementioned studies were both set in first world countries. Tap water in first world countries is acceptable for use due to the water quality in world countries. A world wide generalisation is not likely to be applicable as tap water in third world countries, for example, is not likely to be the same quality as that of a first world country. Moscati et al went one step further and calculated a rough estimate of cost to use tap water compared to normal saline and found that if tap water were to be used to irrigate 8 million lacerations per year across the United States the annual saving would be approximately \$USD65,600,000 (7).

The volume of fluid for irrigation has only been proposed for the combat environment. Murray et al recommended that traditional volumes for irrigation of between 3 and 9 litres of normal saline depending on the type of fracture as classed by the Gustilo and Anderson classification (20), 3 litres for type I, 6 litres for type II, 9 litres for type III (12).

The Gustilo and Anderson classification classes open fractures into three main groups with each group having its own set of characteristics. The characteristics of each group are:

- Type 1 – Clean wound smaller than 1 cm in diameter, simple fracture pattern, no crushing skin;
- Type 2 – A laceration larger than 1 cm but without significant soft tissue crushing, including no flaps, degloving, or contusion. Fracture pattern may be more complex;
- Type 3 – An open segmental fracture or single fracture with extensive soft tissue injury. Also included are injuries older than 8 hours.

There are three sub-categories under Type 3;

- Type 3a - Adequate soft tissue coverage of the fracture despite high-energy trauma or extensive laceration of skin flaps;
- Type 3b - Inadequate soft tissue coverage with periosteal stripping. Soft tissue reconstruction is usually necessary;
- Type 3c – Any open fracture that is associated with an arterial injury that requires repair (21)

Cartotto et al recommended that at the accident scene of chemical burns, irrigation should be done with available fluid, either normal saline or tap water, and should be commenced as soon as possible (17). No data was reported about infection rates. It was simply reiterated that irrigation for certain chemical burns is a fundamental principle as it assists in not only dilution but also the removal of the chemical (17). A single study done by Leonard et al in 1982 did show that burn severity and hospital stay is decreased if irrigation is started in the pre-hospital setting (22). Although specific mention of infection rates were not made in relation to decreased hospital stay, it may be safe to assume that a serious infection was not present. Further research is required to validate these findings. There is also a need to establish what type of irrigation fluid could be beneficial, as well as the length of time for irrigation of chemical burns. When comparing the use of antibiotic solutions versus soap solution it was found that an antibiotic solution offers no advantage over the use of a non-sterile soap solution (18). When soap solution was compared to normal saline in a pilot randomised control trial the results showed no statistically significant difference in infection rates (11).

Based on the current scientific literature, and pending validation of results, tap water appears to be a suitable alternative to normal saline. Comparisons between soap and antibiotic solutions, plus soap solution and normal saline solution did not produce statistically significant results. Normal saline, or tap water as an alternative, seems to be the preferred type of irrigation fluid at this stage (7,8).

Irrigation pressure

It is yet to be determined which type of irrigation pressure is best: high-pressure or low-pressure. Preliminary data at

this stage is favouring low pressure due to its decreased risk of further damage to the wound and surrounding structures (11,19). There is also an argument that the high pressure irrigation may push the bacteria further into the wound (11,19). The definition of low and high pressure varies within the literature, on average low pressure is between 5-10 psi and high pressure is >20 psi. Additionally there was no statistically significant difference between high-pressure irrigation versus low-pressure irrigation (19,23). Pressure can usually be obtained in hospital through irrigation devices. Different pressure can also be obtained by using certain volume syringes and needles. For example a 35 ml and 65 ml syringe with a 19-gauge needle is able to achieve pressures of 25-35 psi (24).

Does irrigation alone affect wound infection rates?

The consensus among experts in the military medicine field is that irrigation is an important factor in wound management for infection prevention (9,12,19). Wounds received in the combat setting can be prone to infection due to the nature and environment of injuries sustained. When considering more minor wounds such as small clean knife cuts infection may not be as prevalent. The types of wounds received in combat and the logistics of the environment could be the likely explanation as to why military practice currently favours the use of irrigation as an early intervention in wound care (12).

The civilian data to date is building against the traditional view that irrigation is a vital part of wound care. Smaller studies comparing infection rates of simple lacerations in specific populations has concluded that there is no statistically significant difference in infection rates between wounds that were irrigated and wounds that were not (3,10). The wounds that were included in this study were clean wounds with little to no foreign materials contaminating the wound. It is important to note that all the studies analysing the effect of irrigation on infection rates include specific population groups only. No studies were found which analysed patients who had immunocompromising factors present, diabetes, or grossly contaminated wounds.

As a result of an unbalanced evaluation of patients, there is inadequate evidence at this stage to prove whether irrigation alone has a significant impact on wound infection rates in the civilian pre-hospital setting.

Limitations of this study

This study is potentially limited by only reviewing articles published in English and the lack of civilian pre-hospital specific articles reporting on wound irrigation and infection rates. This could have resulted in the authors overlooking potentially relevant articles. Most of the studies reviewed were of low-level evidence studies with small study populations. The results should therefore be interpreted with caution.

Conclusion

The evidence reviewed covered a spectrum of wounds ranging from simple clean lacerations to military blast wounds. The military wounds are very likely to have a different infection risk level due to the nature of how the wound was sustained and foreign bodies present in the wound. Therefore it is challenging to generalise results from the military setting into the civilian pre-hospital setting. Further research is required to identify the effect of irrigation on wound categories and the infection rates by category rather than the setting. Due to the varying results identified by this review we suggest that irrigation remain part of civilian pre-hospital wound care, where it is currently in practice, until further research proves its true effect.

Competing interests

The authors declare they have no competing interests. Each author of this paper has completed the ICMJE conflict of interest statement. Dr Malcolm Boyle is an Editor on the Australasian Journal of Paramedicine.

References

1. Australian Bureau of Statistics. Injury in Australia: A Snapshot. Canberra 2004-2005.
2. Gerhardt RT, Matthews JM, Sullivan SG. The effect of systemic antibiotic prophylaxis and wound irrigation on penetrating combat wounds in a return-to-duty population. *Prehosp Emerg Care* 2009;13:500-4.
3. Hollander JE, Singer AJ, Valentine S. Comparison of wound care practises in pediatric and adult lacerations repaired in the emergency department. *Pediatr Emerg Care* 1998;14(1):15-8.
4. O'Meara PM. Management of open fractures. *Orthop Rev* 1992;21:1177-85.
5. Patzakis MJ. Management of open fractures and complications. *Instr Course Lect* 1982;31:62-4.
6. Jacob E, Setterstrom JA. Infection in war wounds: experience in recent military conflicts and future considerations. *Mil Med* 1989;154:311-5.
7. Moscati RM, Mayrose J, Reardon RF, Janicke DM, Jehle DV. A multicentre comparison of tap water versus sterile saline for wound irrigation. *Acad Emerg Med* 2007;14(5):404-9.
8. Bansal BC, Wiebe RA, Perkins SD, Abramo TJ. Tap water for irrigation on lacerations. *Am J Emerg Med* 2002;20(5).
9. Forgione MA, Moores LE, Wortman GW. Prevention of Combat-Related Infections Guidelines Panel. Prevention of infections associated with combat-related central nervous system injuries. *J Trauma* 2011;71(2):S258-63.
10. Hollander JE, Richman PB, Werbuld M, Miler T, Huggler J, Singer AJ. Irrigation in facial and scalp laceration: does it alter the outcome. *Ann Emerg Med* 1998;31(1):73-7.
11. The FLOW Investigators. Fluid Lavage of Open Wounds (FLOW): A Multicentre, Blinded, Factorial Pilot Trial Comparing Alternative Irrigating Solutions and Pressures in Patients with Open Fractures. *J Trauma* 2011;71(3).
12. Murray CK, Hsu JR, Solomkin JS, et al. Prevention and Management of Infections Associated with Combat-Related Extremity Injuries. *J Trauma* 2008;64(3):S239-51.
13. Markenson D, Ferguson JD, Chameides L, et al. Part 17: First Aid: 2010 American Heart Association and American Red Cross Guidelines for First Aid. *Circulation* 2010;122(18 suppl 3):S934-46.
14. Quinn RH, Macias DJ. The Management of Open Fractures. *Wilderness Environ Med* 2006;17(1):41-8.
15. Soreide E, Grande C, editors. *Prehospital Trauma Care*. Boca Raton, Florida, USA: Taylor & Francis Group; 2001.
16. Smith E, Archer F, Burgess S. The development of an updates prehospital search filter for the Cochrane Library: Prehospital Search Filter Version 2.0. *Australasian Journal of Paramedicine* 2010;8(4).
17. Cartotto RC, Peters WJ, Neligan PC, Douglas LG, Beeson J. Chemical burns. *Can J Surg* 1996;39(3):205-11.
18. Anglen JO. Comparison of soap and antibiotic solutions for irrigation of lower-limb open fracture wounds. *J Bone Joint Surg* 2005;87-A(7):1415-22.
19. Murray CK, Obremskey WT, Hsu JR, et al. Prevention of infections associated with combat-related extremity injuries. *J Trauma* 2011;71(2):S235-57.
20. Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analysis. *J Bone Joint Surg* 1976;58:453-8.
21. Kim PH, Leopold SS. In brief: Gustilo-Anderson classification. *Clin Orthop Relat Res* 2012;470(11):3270-4.
22. Leonard LG, Scheulen JJ, Munster AM. Chemical burns: effects and prompt first aid. *J Trauma* 1982;22:420-3.
23. Wheeler CB, Rodheaver GT, Thacker JG. Side effects of high pressure irrigation. *Surg Gynecol Obstet* 1976;143:775-8.
24. Singer AJ, Hollander JE, Subramanian S, A.K. M, Vilez PA. Pressure dynamics of various irrigation techniques commonly used in the ED. *Ann Emerg Med* 1994;24:36-40.